Cathode Coupling Physics in a Hall Thruster

Completed Technology Project (2011 - 2015)

Project Introduction

As humankind seeks to reach Mars and beyond, advancement of electric propulsion (EP) will be a key factor in the pursuit of deep-space exploration. EP uses acceleration methods (electrostatic and electromagnetic), which do not rely on the conversion of heat to kinetic energy. Thus, EP achieves higher specific impulses than chemical propulsion through the acceleration of ionized particles. Among EP devices, magnetoplasmadynamic (MPD) thrusters can provide the high-specific impulse, high-power propulsion required to enable ambitious exploration missions to Mars and beyond. Despite their potential advantages, MPD thrusters have not demonstrated efficiencies near theoretical predictions, which may be due to the 'anode fall' and 'onset' phenomena. The proposed work is to investigate an MPD thruster with a suitable magnetic nozzle that can overcome the limitations imposed by anode fall and onset by controlling the field properties of the plasma in appropriate region of the nozzle and discharge chamber. Computational modeling provides a detailed understanding of the complex physical mechanisms. Improved magnetohydrodynamics models compared to experimental data will provide in-depth understanding of the limiting factors in the MPD thruster and useful insights for an optimal nozzle design. Finally, the proposed nozzle design will be tested numerically and experimentally. The proposed work will improve the overall efficiency of the thruster, critically aid in the development and characterization of next generation MPD thrusters, and contribute to advancing EP for more distant and critical space missions in the future.

Anticipated Benefits

The proposed work will improve the overall efficiency of the thruster, critically aid in the development and characterization of next generation MPD thrusters, and contribute to advancing EP for more distant and critical space missions in the future.

Project Image Cathode Coupling Physics in a Hall Thruster

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

Space Technology Research Grants

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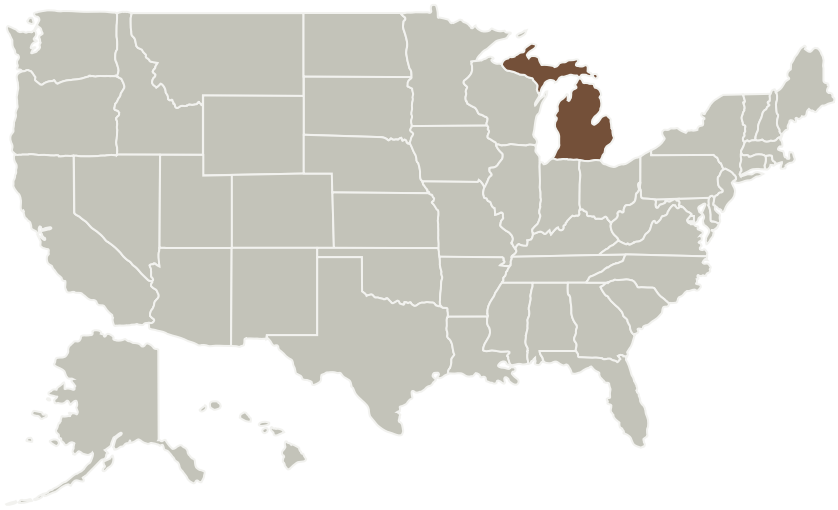
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Michigan-Ann Arbor	Supporting Organization	Academia	Ann Arbor, Michigan

Primary U.S. Work Locations
Michigan

Project Management

Program Director:
Claudia M Meyer

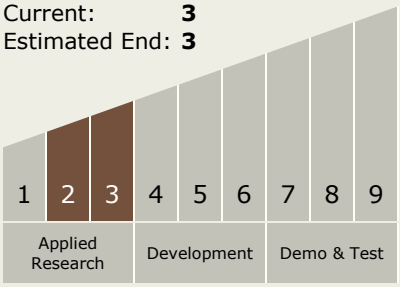
Program Manager:
Hung D Nguyen

Principal Investigator:
Iain D Boyd

Co-Investigator:
Maria Choi

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.2 Electric Space Propulsion
    - TX01.2.3 Electromagnetic

Images

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Project Image Cathode Coupling Physics in a Hall Thruster
(https://techport.nasa.gov/image/1724)

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html